PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Develop And Evaluate Selective Commercial Fishing Gear: Tangle Nets

BPA project number: 20098
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Washington Department of Fish and Wildlife

Business acronym (if appropriate) WDFW

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
8.3, 8.3b, 4.1

FWS/NMFS Biological Opinion Number(s) which this project addresses
10 Sep 98 BioOp - Reinitiation .. Consider Impacts to Listed Steelhead ...
20 Nov 97 Supp. BioOp - Reinitiation… Consider Impacts to Listed Steelhead...
2 Jul 98 BioOp - 1988 Fisheries in the Snake R. Basin...
31 Jul 96 BioOp - Impacts on listed Snake R….

Other planning document references
--WDFW Wild Salmonid Policy. Final EIS. September 1997. Chapter IV, Section 3.3, pg 76-79.
--Snake River Salmon Recovery Plan (NMFS) Section 3.4a

Short description
Operate no-take selective fisheries using a tangle net to exploit strong stocks of anadromous fish while allowing live-release of non-target fish on the Columbia River. Evaluate the post-release survival of all species caught, and compare to gill nets.

Target species

Salmonids in the lower Columbia River.

Section 2. Sorting and evaluation

Subbasin
Mainstem, Lower Columbia

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☒ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?

	This is a new project	

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Coordinate activities with Columbia River commercial fishers and resource managers.	a	Coordinate all objectives, tasks and activities to ensure that all impacts or take of fish, whether listed under the ESA or not, will be consistent with agreements, policies and management principles of the fishery managers of the Columbia River.
		b	Coordinate selection of specific fishing times and places to ensure that the objectives of all parties will be met. Obtain necessary permits to conduct fishery.
		c	Promote dialogue and participation by all parties affected by the development of selective fishing gear.
		d	Host meetings as needed with involved and interested parties to refine work plans and report on progress.
2	Estimate the catch per set to +/- 10% at 95% confidence for the tangle net and conventional gill net fisheries. Estimate the age and size for each species caught to +/- 10% at 95% confidence for the tangle net and conventional gill net fisheries.	a	Purchase and prepare gear, contract with fishermen, train technician. Consult with experienced tangle net operators.
		b	Fish tangle net at several locations for several target species, document fishing.
		c	Collect biological data about catch, tag salmon with numbered visual tag.
		d	Compare the estimates of stock composition of the catch from the

			tangle net with the catch from a commercial gill net fishery.
3	Estimate the proportion of fish caught in the tangle net that are brought aboard dead (can not be revived) by species, to +/- 2% at 95% confidence for each set.	a	Estimate the number of fish from each set that were brought aboard dead after capture in the tangle net.
		b	Estimate the number of fish of each species, size, age and condition grade that were released live. For each fish released live, biological data will be collected to classify the fish.
		c	Document the soak times, hang ratios, and net lengths that maximize the survival of captured fish.
4	For each species, estimate the pecentage of fish released from the tangle net that survive to complete their migration, to +/- 25% at 90% confidence.	a	Notify as many people as possible who are likely to recover a tag about the study. Visit Columbia River sports groups, commercial fishing groups, hatcheries, and biologists in person.
		b	Observe PIT tag detections on dams. Monitor jaw tag recoveries at counting windows on dams. Monitor recapture rates of tagged fish in our experiment and in nearby fisheries.
		c	Hold fish for 24 hours in individual containers and observe condition at release.
		d	Estimate the long-term survival of released fish by recovering tags at spawning grounds and hatcheries.
		e	Radiotag 50 fish per year, representing different species and condition grades when brought on board. Relocate radiotagged fish for 3 days after release. Note subsequent relocations of radiotags during later surveys.
5	Test whether egg viability is affected by capture and release from the tangle net.	a	Select up to three hatcheries where tagged fish are recovered and which have sufficient incubation space.
		b	Spawn tagged fish into separate

			containers. Spawn untagged fish of similar size into separate containers. Rear to eyed stage.
		c	Count number of live eggs per female and compare tagged to untagged fish.
6	Share results of experiment with tribal and non-tribal fishermen and resource managers on the Columbia River and in other areas where this technology might be viable.	a	Prepare written annual report for distribution to interested parties.
		b	Give oral presentations for interested parties and promote discussion. Travel to areas where interest is this technology is high.
		c	Submit article to peer-reviewed journal at completion of study.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	9/2000		Fishing times and dates set, cooperation achieved with interest groups.	8.00%
2	11/1999	09/2000	Estimate of the catch per set, estimate of age and size for each species caught.		23.00%
3	11/1999	9/2000	Estimate of the proportion of dead fish brought on board.		20.00%
4	11/1999	9/2000	Estimate of the percentage of released fish which survive for 24 hours. Relocations of 50 radiotagged fish. Estimate of survival to hatcheries and spawning grounds.		26.00%

5	12/1999	4/2000	Test whether egg viability is affected by capture and release from the tangle net.		15.00%
6	6/2000	9/2000		Reports completed.	8.00%
				Total	100.00%

Schedule constraints
Fishing may be restricted by the Columbia River managers, and by the weather. Insufficient tags released for the 1999 brood may inhibit completion of objectives 2, 3, 4, and 5 in FY1999, and 2000 brood tagged in late FY2000 will be recovered in FY2001.

Completion date
2002

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	5 months + 1 week Biologist 4, 14 months Scientific Technician 3, 2 months Research Scientist 2	%38	70,647
Fringe benefits	For above	%10	19,270
Supplies, materials, non-expendable property	Tangle net, pump, hose, safety equipment, raingear, portable computer, tags, etc.	%13	23,850
Operations & maintenance		%0	0
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	0
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags:	%0	0
Travel	Conferences, community meetings, field sites	%7	13,000
Indirect costs	WDFW Admin. support	%15	26,863
Subcontractor	Gill netter, consulting	%17	31,043
Other		%0	

TOTAL BPA FY2000 BUDGET REQUEST	$184,673

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
WDFW	1 month Biologist 4 and benefits	%2	5,033
WDFW	1 month Research Scientist 2 and benefits	%3	5,909
WDFW	Ground and aerial tracking of radiotags	%5	10,000
WDFW	Boat and motor rental for checking fish held 24 hours	%2	3500
		Total project cost (including BPA portion)	$209,115

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$248,309	$49,715		

Section 6. References

Watershed?	Reference
☐	Baird, J. W. 1983. A method to select optimum numbers for aging in a stratified approach, p. 161-164 in W.G. Doubleday and D. Rivard [ed.]. Sampling commercial catches of marine fish and invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 66.
☐	Parfitt, B. 1998. Wheels, weirs, traps and nets: Selective fishing in BC. BC Aboriginal Fisheries Commission. 27 pp.
☐	Mongillo, P.E. 1984. A summary of salmonid hooking mortality. Washington Department of Game, Fish Management Division, Seattle.
☐	Bendock, T. & M. Alexandersdottir. 1993. Hooking mortality of chinook salmon released in the Kenai River, Alaska. N. Amer. J. Fish. Manage. 13:540-549.
☐	Warner, K. 1979. Mortality of landlocked Atlantic salmon hooked on four types of fishing gear at the hatchery. Prog. Fish-Cult. 41:99-102.
☐	Gjernes, T., A.R. Kronlund & T.J. Mulligan. 1993. Mortality of chinook and coho salmon in their first year of ocean life following catch and release by anglers. N. Amer. J. Fish. Manage. 13:524-539.

PART II - NARRATIVE

Section 7. Abstract

On the mainstem Columbia River, salmon may be harvested in mixed stock commercial fisheries such that fishers targeting salmon from stronger runs inadvertently catch weaker species and stocks. Our goal is to evaluate tangle nets as selective fishing gear for exploiting strong anadromous fish stocks while allowing live-release of non-target fish species and stocks on the Columbia River. We will conduct a no-take commercial fishery using the tangle net on the lower Columbia River. Activities will be coordinated with Columbia River fishers and resource managers. The ability of the net to catch target fish and the survival of released fish will be evaluated. This project addresses Measure 8.3 (Develop alternative harvest opportunities) in the Columbia Basin Fish and Wildlife Program. The tangle net will be fished at different times for a variety of target species and the catch biologically characterized. In the first year one net will be fished, and in the second year, two will be fished simultaneously. Live fish brought on board will be tagged and biological data will be collected before release. To evaluate short-term survival, up to 20 salmon per fishing day will be held in individual containers for 24 hours before release or tagged with a radiotag for later relocation. Survival will also be estimated from tag recoveries. The composition of the catch from the tangle net will be compared to conventional gill net fisheries. At the end of this three-year project, we expect to be able to recommend whether tangle nets are a viable selective fishing gear and should be admitted into the fisheries. Our results will be presented in annual reports and submitted for publication in a peer-reviewed journal.

Section 8. Project description

a. Technical and/or scientific background

On the mainstem Columbia River, salmon may be harvested in mixed stock commercial fisheries where different species and stocks intermingle. This is a problem because weaker species and stocks are caught inadvertently by fishers targeting salmon from stronger runs. Protecting weak salmon stocks originating in the Columbia River has required a substantial reduction of the commercial harvest of salmon, even though there are healthy stocks that could be exploited if the weak stocks could be avoided or released unharmed. One of the most significant ways commercial fishers can contribute to conservation is through selective harvesting technologies and practices which would allow a continued harvest, while protecting weak stocks. “Selective fishing” means “the ability to target and capture fish by species, size or sex during harvesting operation, allowing all by-catch to be released unharmed. By-catch may include small (juvenile) fish, non-target fish species, birds and other marine organisms encountered during fishing” (United Nations FAO, 1994, Expert Consultation for the Code of Conduct for Responsible Fishing Operations). For the Pacific Northwest, the definition of by-catch must be expanded to include non-target stocks of a fish species.

In 1996, WDFW and other West Coast resource managers began marking hatchery reared coho and will soon begin marking hatchery reared chinook to distinguish them from naturally produced fish. One of the primary objectives of this mass marking is to allow a directed, selective harvest on hatchery fish. The remaining commercial fisheries on the Columbia River are highly regulated gill net fisheries targeting sturgeon, shad and salmonids. To assist some of the fishers, Northwest Power Planning Council is funding a program to develop and evaluate terminal area fisheries. Developing selective fisheries on the river would complement that program by allowing participation by more fishers in areas where terminal fisheries do not occur. Live releasing non-target fish would mitigate pressure on weak stocks. While it has not yet been used on the Columbia River, the use of a tangle net is gaining support in British Columbia as an efficient selective gear. A tangle net is analogous to a small meshed gill net (mesh size is 3.5") made from multifilament web, and tangles the fish by the maxillary or teeth rather than gilling the fish, which allows the fish to be released live. In an ongoing study, Fraser River fishers have had encouraging results live-releasing salmonids of all species from a tangle net. The evaluation of the survival of these fish to spawning is still in progress, but the initial results are promising. More than 87% of all species were live released, and most of the dead fish were killed by seals (Parfitt, 1998). Furthermore, because of the careful handling and the very high quality of fish caught, the market value of the catch has been significantly higher than from conventional gears. Because careful release of live fish requires more time than a conventional fishery, the catch per unit effort is generally expected to be low. When this is the case, we would expect the opening times for commercial fisheries using selective gear to be lengthened to allow the fishers time to catch their allocation. We propose to test the tangle net as a selective gear for salmon on the Columbia River.

b. Rationale and significance to Regional Programs

The Northwest Power Act has a major goal of rebuilding and protecting populations affected by the construction and operation of the Columbia River dams. The Act also recognizes the economic importance of anadromous fish. These two parts of the Act tie commercial fishing to conservation, which seem to be in direct conflict because the fastest and most reliable way to rebuild populations is to maximize returns of adults from those populations, not to capture them in downstream fisheries. Conventional gill nets are not designed to allow live-release of non-target species or stocks encountered, although they can effectively reduce encounters with non-target fish by time and area closures. If non-target fish could be released in good enough condition to continue their migration, then the goal of protecting weak stocks could be met while realizing the economic value of healthy stocks in a commercial fishery. Rather than force commercial fishers out of the Columbia River through conservation closures, the Northwest Power Planning Council proposed Measure 8.3, "Develop alternative harvest opportunities" which promotes development of technologies for live capture of fish so that non-target fish can be released. Our project goal is to develop and evaluate a selective harvest technology, as proposed in Measure 8.3b. The point of selective harvest gears is to release fish belonging to weak stocks, which will contribute to Measure 4.1, "Salmon and steelhead goal: Double salmon and steelhead runs without loss of biological diversity.",

by allowing more protected fish to escape to the spawning grounds. Recovering tags and the data we will be collecting about gill net fisheries will contribute general biological data about migrating adults in the Columbia River.

c. Relationships to other projects

Developing selective fishing technology for mixed-stock fisheries complements the development of terminal harvest fisheries (Project #930600, Evaluate Columbia River Select Area Fisheries) by allowing participation by gears that might not be suitable for terminal area fisheries, while minimizing harvest of weak stocks. Select area fisheries can support some, but not all of the fishers. Development of selective fisheries will further expand opportunities. Our test of the tangle net can be compared to tests of similar gear in British Columbia, and scientists from Fisheries and Oceans Canada are sharing their outcomes and experience with us.

This project requires cooperation and collaboration with all the fishery resource managers on the Columbia River. Commercial harvest regulations require Columbia River Compact action in concurrent waters and state action in state waters. The Oregon Department of Fish and Wildlife (P. Fraser, communication to Cindy Lafleur, WDFW) has already expressed their support of this project. Coordination with the appropriate enforcement agencies is essential. All harvest must be addressed in the ESA process involving the Technical Advisory Committee of the Columbia River Fish Management Plan for biological assessment of the fishery impacts. Final approval of fisheries and harvest are then the responsibility of the National Marine Fisheries Service.

Cooperation and coordination with commercial fishers is essential. The Washington based Northwest Gillnetters Association (Lee Clark, President, pers. comm.) supports this project because of the potential benefits to their industry.

d. Project history (for ongoing projects)

This is a new project.

e. Proposal objectives

Our goal is to evaluate tangle nets as selective fishing gear to allow exploitation of strong anadromous fish stocks while minimizing impacts on depressed fish stocks on the Columbia River.

Objective 1: Coordinate activities with Columbia River commercial fishers and resource managers.

Task 1a: Coordinate all objectives, tasks and activities of the project to ensure that all impacts or take of fish, whether listed under the ESA or not, will be consistent with agreements, policies and management principles of the fishery managers of the Columbia River.

Task 1b: Coordinate selection of specific fishing times and places to ensure that the objectives of all parties will be met. Obtain necessary permits to conduct fishery.

Task 1c: Promote dialogue and participation by all parties affected by the development of selective fishing gear.

Task 1d: Host meetings as needed with involved and interested parties to refine work plans and report on progress.

Objective 2: Estimate the catch per set to +/- 10% at 95% confidence for the tangle net and conventional gill net fisheries. Estimate the age and size for each species caught to +/- 10% at 95% confidence for the tangle net and conventional gill net fisheries.
Assumptions: Target fish are present and available to be caught during the test fishery. There will be times when the commercial gill net fishery overlaps with the test fishery. The conventional gear will be fished without extra bias caused by participation in the study, so the catch will reflect the actual commercial fishery. When subsamples are required, all fish caught in the net have an equal chance of being sampled.

Task 2a: Prepare and purchase gear, contract with fishers, train technician.

Task 2b: Fish tangle net at several locations for several target species.

Task 2c: Collect biological data about catch, tag fish with numbered visual tags.

Task 2d: Compare the estimates of stock composition of the catch from the tangle net with the catch from a commercial gill net fishery.

Objective 3: Estimate the proportion of fish caught in the tangle net that is brought aboard dead (can not be revived) by species, to +/- 2% at 95% confidence for each set.
Assumptions: The tangle net does catch fish. Fishing and handling techniques will be modified during the study so that mortality can be minimized as our experience grows.

Task 3a: Estimate the number of fish from each set that were brought aboard dead after capture in the tangle net.

Task 3b: Estimate the number of fish of each species, size, age and condition grade that were released live. For each fish released live, biological data will be collected to classify the fish.

Task 3c: Document the soak times, hang ratios, and net lengths that maximize the survival of captured fish.

Objective 4: For each species, estimate the percentage of fish released from the tangle net that survive to complete their migration, to +/- 25% at 90% confidence.

Assumptions: Enough fish can be caught and tagged and enough tags recovered for statistical analysis. A sampling effort can be assigned so the tag recoveries can be expanded. A fish which is recovered at a hatchery rack or trap will be classified as having completed its migration, even though we can not be sure it wouldn't have continued on to some other location than the place where it was trapped. A fish that survives 24 hours will survive to complete its migration. Capture and handling, rather than the presence of a tag are the causes of differential mortality between captured and uncaptured fish.

Task 4a: Notify as many people as possible who are likely to recover a tag about the study. Visit Columbia River sports groups, commercial fishing groups, hatcheries, and biologists in person.

Task 4b: Observe PIT tag detections on dams. Monitor jaw tag recoveries at counting windows on dams. Monitor recapture rates of tagged fish in our experiment and in nearby fisheries.

Task 4c: Hold fish for 24 hours in individual containers to observe mortality.

Task 4d: Estimate the long-term survival of released fish by recovering tags at spawning grounds and hatcheries.

Task 4e: Radiotag 50 fish per year, representing different species and conditions when brought on board. Relocate radiotagged fish for three days after release. Note subsequent recoveries during other surveys.

Objective 5: Test whether capture and release from the tangle net affect egg viability.

Hypothesis: At each hatchery, the egg viability of fish released from the tangle net will be significantly lower than the egg viability of fish that were not captured, at 95% confidence.
Null Hypothesis: At each hatchery, the egg viability of fish released from the tangle net will not be significantly different than the egg viability of fish that were not captured, at 95% confidence.
Assumptions: Acceptance of the null hypothesis assumes sufficient statistical power. The untagged fish were not captured and released from some other fishery. Any fish with obvious signs of capture (e.g. the presence of a hook, torn jaws, seal bites) will be eliminated from the study. The size of the released fish and the rest of the spawning population are the same. If not, the data will be stratified to standardize size between the two groups.

Task 5a: Select up to three hatcheries where tagged fish are recovered and which have sufficient incubation space.

Task 5b: Spawn tagged fish into separate containers. Spawn untagged fish of similar size into separate containers. Rear to eyed stage.

Task 5c: Count the number of live eyed eggs per female and compare the number for tagged and untagged fish.

Objective 6: Share results of experiment with tribal and non-tribal fishers and resource managers on the Columbia River and in other areas where this technology might be viable.

Task 6a: Prepare written annual report for distribution to interested parties.
Product: Written report detailing our findings and recommendations.

Task 6b: Give oral presentations for interested parties and promote discussion. Travel to areas where interest is this technology is high.
Product: Oral presentations detailing our findings and recommendations.

Task 6c: Submit article to peer-reviewed journal at completion of study.
Product: Widely distributed written report detailing our findings and recommendations.

f. Methods

Preparation

1. Obtain agreement from Columbia River managers on specific sites and times for testing selective fishing gear. Several sites for testing the gear will be selected on the lower Columbia River with the following characteristics considered: proximity to areas where visual tags are likely to be recovered, appropriateness of the site for the gear and the probable presence of fish. All impacts or take of fish will be consistent with the agreements, policies and management principles of the fishery managers of the Columbia River. Throughout the project, we will host meetings with Columbia River managers and local fishing groups to obtain support, information, to modify the project when necessary and to report on progress. (Tasks 1a, 1b, 1c, 1d)

2. Obtain permits to conduct an experimental test fishery and ESA take permits for listed species. We are proposing a no-take fishery to evaluate the effectiveness of the gear in releasing fish, so the expected take and fishery impacts would be low. (Task 1b)

3. Contract with Columbia River gill-netters for participation in trying new gears in no-take fisheries. Depending on the site chosen, we will contract with either

tribal or non-tribal fishers to fish the tangle net on a per-day basis. The fishers will be paid a daily rate and will not keep the catch, to reduce bias. (Task 2a)

4. Consult with BC fishers and researchers already using similar selective gears. The tangle net has been successfully fished on the Fraser River, and we can progress quickly by using the expertise developed there. Mark Petrunia, a Fraser River fisher, has expressed interest in sharing his experience with handling and fishing techniques. (Task 2a)

5. Purchase and prepare gear for one boat in the first year, and for two boats in the second year. Gill net boats will require little modification except the set up of a recovery tank for tagged fish. The holding tank on most gill net boats can be outfitted with a pump and hose to supply fresh water to live fish, and to revive fish when necessary. (Task 2a)

6. Before we begin fishing, appropriate hatchery personnel, Columbia River biologists, spawning ground surveyors, and fishers will be alerted to look for the tags, and about how to contact us. As much as possible, we will visit with all these groups in person and share the project goals and objectives with them. We will distribute information sheets requesting that the following information be provided for each tag recovered: the tag number, the location where it was recovered, the date when it was recovered and how it was recovered (e.g. Sport fishery, spawning ground survey, observed at dam, etc.). Biologists and hatchery personnel will be asked to grade live fish according to the 5-tiered grading system. Spawning ground surveyors will be asked to indicate whether the fish was spawned out or not. (Task 4a)

Data Collection

1. In the first year, the tangle net will be fished in only one boat at a time. A technician will be posted aboard during all fishing trips. The technician will be trained in handling and releasing fish, collecting biological data, tagging fish and releasing fish. In the second year, two nets will be fished simultaneously so that comparisons can be made between the catches and fishing techniques. In the second year, a technician will be posted aboard each boat during all trips. Each technician will be equipped with appropriate safety gear and will be trained in safe boating procedures. (Task 2b)

   The third year of the project will not include fishing, but we require time to complete tag recoveries, fecundity measurements, data analysis and information dissemination.

2. Standardize handling and release procedures of fish. In tests of selective fishing gear made in British Columbia, the handling and release procedures of the fish were the most important determinants of a fish's chance for survival (Brent

Hargreaves, Fisheries and Oceans Canada, pers. comm.). We will require that the fishers and technicians use the least stressful methods for releasing and reviving fish possible. Again, the experience of fishers already successful with this gear will greatly speed our progress. (Task 2b)

3. The tangle net will be fished in as many different locations and target as many different species as will be allowed by Columbia River resource managers for up to 60 days per year. We expect the tangle net will have a lower catch per unit of effort than conventional gill nets, because careful release of non-target fish must not be rushed. For every set that the net is fished, location, depth, start and end times, weather conditions, water temperature, length of net set and hang ratio will be recorded. (Task 2b, 3c)

4. During every fishing trip, the catch of salmonids will be extensively characterized and the fish will be tagged before release. Any species other than a will be counted then released immediately. All salmonids will be brought on board and placed in a holding tank supplied with fresh water, and held until all fish in the set have been released from the net. Holding and handling time will be kept as short as possible, and the next set will not begin until all the fish have been processed.

   Live salmon will be gently restrained, and the following data will be collected from every fish or from a representative group depending on the size of the catch: species, marks or tags already present, fork length, sex, age (by removal of non-regenerated scales), and seal marks. Each fish will be interrogated for PIT tags so that later recoveries will add survival data to our study. Each fish will be visually checked for scarring, surface bruising, scale loss, and liveliness and then graded based on the following criteria developed by Fisheries and Oceans Canada for selective fishing experiments: Grade A – No obvious surface bruising, marking or scale loss; undamaged and fish active in the water; Grade B - Some evidence of slight damage, less than 5% scale loss, but no significant surface damage, less than fully active; Grade C – Evidence of bruising, more than 5% scale loss, and other surface markings; Grade D – Fish not lively in the water; Grade E – Dead. The number of dead salmon will be recorded by species, and biological data, including the probable cause of death (e.g. seal attack, entanglement) will be noted. Age will be determined for up to 2000 fish per year, from the tangle net and commercial gear combined. We expect the catch to be greater than 2000, so scales will be subsampled using the stratified approach described by Baird, 1983. Using this approach, the appropriate numbers for aging in each length class are selected for each species. (Task 2c, 3a, 3b)

   Once the biological data are collected, the fish will be tagged with a brightly colored numbered jaw tag, revived, dipped in a mucous stimulating bath (such as acetic acid) and released. The jaw tags can be seen as a fish passes through counting windows at dams, they have a high retention rate and are obvious for spawning ground surveyors or fishery recoveries. The numbering will allow us to

relate the survival of an individual fish to its condition grade when it was originally captured in the tangle net. (Task 2c)

Other studies have shown 80% of the hooking mortality of adult salmon occurs within 2 to 3 days of release (Bendock and Alexandersdottir, 1993; Mongillo, 1984; Warner, 1979) and within 15 minutes for first year ocean fish (Gjernes, Kronlund & Mulligan, 1993). In this study, we will assume that short-term mortality occurs within 24 hours after capture, because 24 hours is the longest we expect fish can be held without incurring holding effects. We will verify this assumption using radiotracking, as described below. To estimate the proportion of released fish that survive at least 24 hours, we will hold up to 20 fish per day for 24 hours in individual PVC and canvas containers. Fish will be randomly selected from each species and each condition grade at capture. The fish will be dipped in a mucous-stimulating bath and placed into a container. The containers are perforated to allow water circulation and will be attached to an anchor line in calm, but sufficiently aerated, water close to the fishing site. After 24 hours, the condition of the fish will be noted, based on the 5-tiered grading system. All live fish will be immediately released. (Task 4c)

To verify our assumption that mortality within 24 hours represents the short-term mortality caused by capture and release, we will radiotag and relocate 50 fish per year. The fish will represent each species caught and the different condition grades of the fish when they are brought on board. Fish that receive radiotags will be anesthetized so that the tag can be inserted into the stomach cavity. Each fish will be revived and dipped in a mucous stimulating solution, then released. The radiotags will be relocated for three days after release using ground and aerial surveys. Although it can be difficult to determine if a fish is live or dead when it is recovered in a current, we will attempt to determine the status for each fish. Subsequent recoveries of the same tag will help confirm the status assignments. There will be opportunities to relocate tags after the original three days during tracking for new tags, and in cooperation with other tracking projects. These recoveries will provide information about the disposition of the fish and contribute to our understanding of long-term survival. (Task 4e)

We may be able to obtain qualitative data about the short-term survival of previously PIT-tagged fish as they pass over Granite Dam, and will be registered in the PIT tag database. Where there are counting windows on dams, observers will be able to see the jaw tags. Tagged fish may also be recaptured in our study or in nearby fisheries which will provide further qualitative survival data. (Task 4b)

5. Whenever the test fishery using the tangle net coincides with a comparable gill net fishery, a second technician will be posted on board a gill net boat to characterize the catch. In this case, the gill-netter will volunteer to have the technician on board, so that the fishery will be competitive, making his catch representative of the real fishery. The same biological data will be collected as

for the tangle net, except the condition will be automatically assigned as dead. This will allow statistical comparisons of the catch by each gear. Simultaneous fisheries will also provide some indication of the recapture rate that could occur on the fish released from the tangle net. Although we may be able to release the fish successfully one time, the cumulative impacts of repetitive recaptures and releases might kill the fish. Repetitive recapture may be an important source of mortality in a full fleet selective fishery. (Task 2d)

6. Because the stress from being captured could affect a fish's ability to spawn, we will measure the egg viability of fish released from the tangle net and compare it to the egg viability of uncaptured fish as controls at three appropriate hatcheries. The hatcheries will be selected after the fish have returned. The sites must have 50 tagged fish or more and sufficient incubation space available. Fifty fish from each group will be measured then spawned into an individual container and the eggs fertilized and disinfected normally. The eggs will be kept separate until they are eyed, when they will be counted. Because fecundity is directly related to the size of a fish, control fish will be selected to represent the same fork length as the test fish. A sample size of 50 females will provide a 90% chance of detecting a difference of at least 200 viable eggs at the 0.05 level of probability. If we do not recover enough fish at a hatchery to make a statistically valid comparison, we will still measure the egg viability of tagged fish, and of several untagged fish to determine whether the ranges overlap. (Task 5a, 5b, 5c)

Evaluation and Data Analysis

1. Ability to catch target fish. The number of target fish caught will be recorded for each fishing trip. This will be compared to a conventional gill net fishery whenever the two fisheries occur simultaneously. The catch per unit effort will be calculated and compared for each gear. (Objective 2)

2. Avoidance of non-target fish. The number of non-target fish will be recorded for each fishing trip, and compared to estimates from conventional gill net fisheries whenever the two fisheries occur simultaneously. (Tasks 2c, 2d)

3. Live fish release. The proportion of fish brought on board dead and the proportion released live will be estimated for each set and for each species. The effects of fork length, fishing methods (soak time, net length, etc.), and water temperature on mortality will also be examined. Finally, we will look for trends over time because we expect that experience will help decrease mortality. (Objective 3)

4. Short-term survival. A recovery of a tag will indicate short-term survival if the tag is recovered anywhere other than a hatchery rack or spawning ground. The percentage of live fish of each species remaining after 24 hours of holding will be estimated for each species caught and by condition grade when brought on board. The percentage of live radiotagged fish of each species relocated three days will

be estimated. This and later relocations will help substantiate our assumption that a fish which survives 24 hours will survive to complete its migration. In each case, observations of a recapture will be related back to the fish's condition when it was brought on board in the tangle net. (Objective 4)

5. Long-term survival. The long-term survival will be estimated by recovering tags on spawning grounds and at hatcheries. The recovery of an individual fish will be related to its condition when it was brought on board in the tangle net. The tag recovery effort will be estimated and the recoveries expanded to estimate the survival. (Objective 4)

6. The estimates of egg viability for captured and uncaptured fish will be tested against our hypothesis that capture and release from the tangle net will significantly lower egg viability. (Objective 5)

7. Our results will be widely available through reports, presentations and submission to a peer-reviewed journal. (Tasks 6a, 6b, 6c)

g. Facilities and equipment

Pickup truck for technician to haul net, sampling equipment
(I can not delete the above line!)

The project will be administered from the WDFW office in Olympia, but project equipment will be stored at other agency facilities close to the Columbia River. Office space will be provided at existing WDFW facilities in Olympia or other regional sites. The boat required for checking fish held in containers for 24 hours and for radio tracking will be supplied by WDFW. Antennas and other equipment for radio tracking will be supplied by WDFW. Vehicles for the principle investigator and project manager will be rented from WDFW on an as-needed basis. A pickup truck for the technician to haul net, sampling equipment will be rented from WDFW.

h. Budget

We are requesting funding for 5 months Biologist 4, 14 months Scientific Technician 3 and 2 months Research Scientist to coordinate and conduct the research project. Considerable time will be required to set fishing times and places in preparation for the project. Data analysis will also be performed by these positions. Fishing time, data collection, radiotag surveys, jaw tag recoveries and estimating the gamete viability merit the assistance of a full-time technician. Simultaneous sampling of the commercial gill net fishery requires part-time assistance from a second technician. The State of Washington sets fringe benefits for these positions.

Equipment purchases include a complete tangle net gear for one boat, a pump for the holding tank, safety equipment and raingear for on-board sampling, a portable computer for use in the field, 10,000 numbered jaw tags, a portable PIT tag detector and 50 radiotags.

Travel includes vehicle mileage, per diem and lodging, and travel to community meetings and conferences.

Indirect costs are for WDFW administrative support.

Subcontracts are for consulting fees with experienced fishermen at $250/day for 12 days, and for gill-netters (with boat and fuel) for fishing at $400/day for 60 days.

Section 9. Key personnel

Blankenship, H. Lee – Project Manager
WDFW Senior Research Scientist
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(360) 902-2748

Education: B.S. in Fisheries, University of Washington (1969)

Employment: WDFW Research Scientist (1972-present)

Professional Recognition: Adjunct Scientist, Mote Marine Laboratory, Florida; Visiting Scientist, Oceanic Institute, Hawaii; Associate Editor, North American Journal of Fisheries Management

Expertise and Experience: Blankenship has been a Senior Research scientist with the Washington Department of Fish and Wildlife for the past 13 years. During this time, he has completed several large fisheries related studies. Among these are three BPA sponsored projects: 1) upstream passage, spawning and stock identification of fall chinook in the Snake River (1991-1996); (2) Effects of coded-wire tagging on the survival of spring chinook (1989-1998); and (3) An automated fish marking and tagging system (1992-1998). Besides his project management skills, he possesses knowledge on fish capturing, fish handling and tagging techniques.

Publications:
Blankenship, H.L. 1990. Coded-wire tag loss in chinook and coho salmon. Amer. Fish. Soc. Symp., 7, 237-243.
Buckley, R.M. and H.L. Blankenship. 1990. Internal extrinsic identification systems: an overview of implanted wire tags, otolith marks, and parasites. Amer. Fish. Soc. Symp., 7, 173-182.

Blankenship, H.L. and J.Tipping. 1993. Evaluation of visible implant and sequential coded-wiere tags in sea-run cutthroat trout. N. Amer. J. Fish. Manage. 13, 391-394.

Guy, C.S., H.L. Blankenship, and L.A. Nielsen. 1996. Tagging and marking. Pages 353-383 in B.R. Murphy and D.W. Willis, ed. Fishery Techniques. Amer. Fish. Soc. , Bethesda, MD.

Blankenship, H.L. and G.W. Mendel. 1997. Upstream passage, spawning, and stock identification of fall chinook in the Snake River, 1992 and 1993. Bonneville Power Administration. Portland, OR. DOE/BP 96-046.

Geraldine Vander Haegen - Principle Investigator
WDFW Biologist
600 Capitol Way North
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(360) 902-2793

Education: B.Sc. in Biology, McGill University, Quebec, 1989
M.Sc. in Fisheries, McGill University, Quebec, 1991

Employment: WDFW Biologist, 1994 – present
Maine Atlantic Sea Run Salmon Commission 1993, 1994
Maine Department of Inland Fish and Wildlife, 1993
Fisheries and Oceans Canada, Science Branch, 1991-1993

Expertise and Experience: Vander Haegen has coordinated and completed several fisheries related research projects with WDFW since 1994. These have included an examination of homing by hatchery fish, production and evaluation of triploid salmonids, and evaluating natural rearing techniques for production hatcheries. She also has experience handling and tagging fish, statistical analysis, and report presentation.

Publications:
Vander Haegen, G.E., J.T. Tipping, S. Hammer. 1998. Consumption of juvenile salmonids by adult steelhead in the Cowlitz River, Washington. California Fish and Game. 84/1 (1998),

Cornel, G.E. (later Vander Haegen, G.E.) & F.G. Whoriskey. 1994. The effects of rainbow trout (*Oncorhynchus mykiss*) cage culture on the water quality, zooplankton, benthos and sediments of Lac du Passage, Quebec. Aquaculture 109(2):101-118.

Section 10. Information/technology transfer

All information obtained from this study will be documented in annual technical reports and by a final report published in a peer-reviewed journal. Oral reports about our project will be presented to the commercial fishing industry and fishery managers. We will present our project at technical workshops and conferences on this subject.

Congratulations!